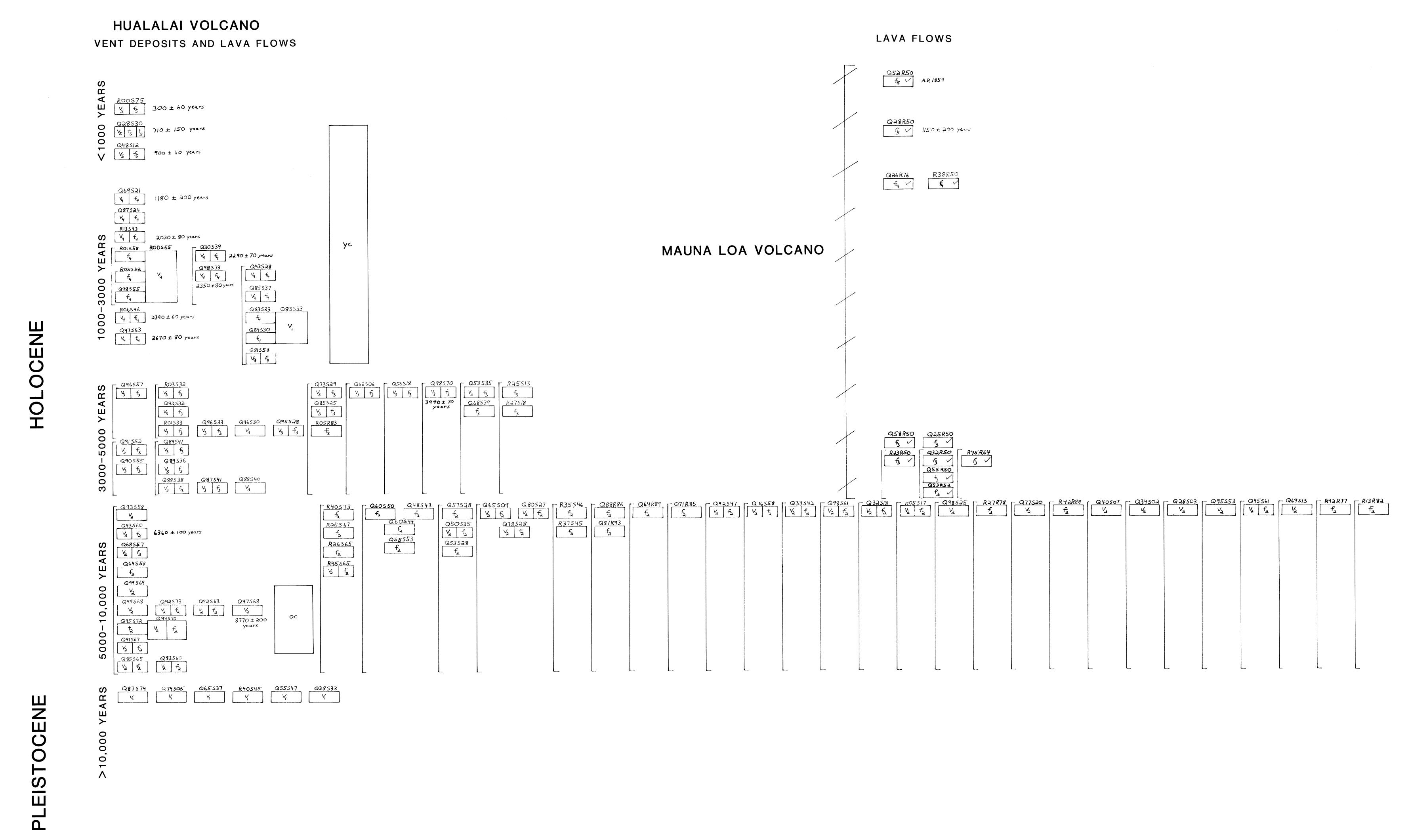
CORRELATION OF MAP UNITS



GEOLOGIC SUMMARY The Hualalai quadrangle includes the summit of Hualalai Volcano, most of its major south-southeast-trending rift zone, and most of its diffuse north-trending rift zone. The rift zones are marked by steep-sided spatter and cinder cones and a few satellitic shields; open cracks and normal faults, prominent on Kilauea and Mauna Loa Volcanoes, are virtually absent. Eleven tholeiitic basalt flows from Mauna Loa Volcano cover the eastern ten percent of the quadrangle, where they are interbedded with alkali olivine basalt flows of Hualalai. Most of the area is relatively arid, receiving less than 80 cm of rain per year, although fog is common. Basaltic lavas of Hualalai in this quadrangle range in age from latest Pleistocene to 300 years old. The oldest lavas form seven small cones that cover less than one percent of the area. They could be earliest Holocene, but extensive weathering and soil development $\Diamond 0.3$ m), the virtual absence of surficial glass and a ^{14}C age of 8,770 \pm 200 years on an overlying cone suggest that most of these Layas that are 5,000-10,000 years old cover about 10 percent of the quadrangle. Their assignment to this age classification is based on absence of delicate primary flow structures, extensive weathering, development of soil 0.3 m thick or less, stratigraphic relations, and a few ^{14}C ages. Most of the large cones in the summit area are of this age, as are several extensive flows in the southwest part of the map and a few isolated cones and flows scattered along the rift zones. Lavas that are 3,000-5,000 years old cover about 30 percent of the quadrangle. Cones and flows are generally weathered brown with little or no soil cover, except in the rain forest. Primary spatter and flow structures generally are present, as is local surficial glass. Stratigraphic relations and a few 140 ages are further aids in assignment of volcanic units to this age classification. Lavas that are 1,000-3,000 years old cover about 40 percent of the quadrangle. Stratigraphic relations and several 14C ages document that Hualalai was remarkably active during this period, with at least ten large ($>200 \times 10^6 \text{ m}^3$) eruptions from different vents scattered across the volcano. Lavas of this age generally are black or dark grey, lack soil, except in the rain forest, and commonly have surficial glass and delicate primary flow and spatter structures. Three large eruptions have occurred during the last 1,000 years; their lavas cover about 10 percent of the quadrangle. Like the 1,000-3,000-year-old lavas, these are black or dark grey, lack soil, and have surficial glass and delicate primary spatter and flow structures. They are distinguished from the older lavas by stratigraphic relationships and 14C ages. The youngest activity demonstrates that Hualalai is only a dormant volcano and can be expected to erupt again, perhaps within the next few decades (Moore and others, in press). Denosits of basaltic cinders cover much of the quadrangle, although they are mapped only where underlying units cannot be recognized. Eight sources of young cinders, defined by their fresh glass and black, brown, or red color, have been recognized. Older, palagonitized, yellow-brown cinders cover much of the summit area and probably came from several of the vents that are clustered there. Thin alluvial and colluvial deposits are present but have not been mapped. Alkali olivine basalts of the Hualalai quadrangle contain variable amounts (estimated in the field) of olivine, plagioclase, and pyroxene phenocrysts; a few basalts are aphyric. MgO contents range from about 4-16 percent; the lowest values occur in basalts that are transitional to hawaiite, and the highest values occur in

lavas that contain abundant olivine and pyroxene phenocrysts and approach ankaramite

in composition. The latter commonly have abundant xenoliths of dunite, pyroxenite,

and gabbro, although similar xenoliths also occur in less porphyritic lavas.

Tuff on the north rim of Hainoa Crater (near west-central edge of map) and 29557a on north wall of pit crater transecting v_2 097S68. Consists of red to yellow palagonitic tuff, up to 1 m thick, with boulders of the underlying f₂Q94S70 and gabbro and diabase from a subjacent intrusion. Tuff is interpreted as the deposit resulting from explosive phreatic eruptions accompanying the formation of Hainoa Crater near the end of construction of a satellitic shield (f₂Q94S70). At Hainoa Crater, tuff is overlain by a single hybrid flow consisting of mixed hawaiite with less than 1 percent plagioclase phenocrysts and alkali olivine basalt with 5-10 percent plagioclase, 2-5 percent olivine, and less than 1 percent pyroxene phenocrysts. Two hundred m north, in cone v_2 Q97S68, the tuff is overlain by 6 m of flows of unit f_2 Q94S70 Spatter deposits and pahoehoe and aa flows in and near Hainoa Crater (near

Q94570 west-central edge of map). The deposits are associated with formation of a va fa satellitic shield near the summit of Hualalai Volcano. Shield-building flows of this map unit also crop out in the bottoms of pit craters at cones v2Q97S68, v_2 099S69, and v_4 R00S55 (Nawahine). Consist of alkali olivine basalt, transitional to hawaiite, with 8-12 percent plagioclase, 2-4 percent olivine, and 1-2 percent pyroxene phenocrysts; xenoliths of dunite, pyroxenite, and gabbro occur in two of the pyroclastic deposits. Q91567 Spatter cone of Puu Lalakaukole (near west-central edge of map; forms summit f Hualalai Volcano) and aa and pahoehoe flows. Consist of alkali olivine basalt with 5-10 percent olivine, 5-10 percent plagioclase, and less than 1

Widespread airfall cinders of alkali olivine basalt, representing the products of vigorous Strombolian or sub-Plinian eruptions. Cinder deposits are up to several meters thick and are yellow-brown. Sources include Hainoa Crater and

percent pyroxene phenocrysts; scattered xenoliths of gabbro and anorthosite

possibly other nearby vents. Not mapped where underlying units can be

Q85565 Spatter cone and an aa and pahoehoe flow in the west-central part of the map. Consist of alkali Olivine pasart with a percent pyroxene phenocrysts. Consist of alkali olivine basalt with 5-10 percent plagioclase, 2-4 percent Q83560 Spatter deposits (including Kumukou) and-short aa and pahoehoe flows in the est-central part of the map. Kumukou and another small cone are compose of pahoehoe with almost no spatter. Consist of alkali olivine basalt with 3-8 percent plagioclase and 1-3 percent olivine phenocrysts.

a and pahoehoe flow in the northwest corner of the map. Consists of alkali livine basalt with 4-8 percent olivine phenocrysts. Aa and pahoehoe flow in the northwest corner of the map. Consists of alkali olivine basalt with 3-6 percent plagioclase and 1-2 percent olivine phenocrysts. **R26565** Aa and pahoehoe flow in the northwest part of the map. Consists of alkali olivine basalt with 8-12 percent olivine phenocrysts. $\begin{array}{c} R45 \le 6.5 \\ \hline V_a & f_a \\ \end{array}$ Spatter and cinder cone of Poohohoo (northwest corner of map) and a pahoehoe flow. Consist of alkali olivine basalt with 10-15 percent olivine phenocrysts low. Consist of alkali olivine basalt with 10-15 percent olivine phenocrysts.

Trachytes occur as xenoliths in three basaltic cinder deposits; they generally are aphyric in hand specimen, but microscopy indicates that nepheline and sodalite microphenocrysts are present in some samples. DESCRIPTION OF MAP UNITS

Vent deposits, consisting of spatter that forms ramparts and cones, and a pahoehoe flow (flow is partly aa in the adjoining Kailua quadrangle); source

(M. Rubin, written commun., 1979). Qa8530 Spatter deposits, lava flows, and trachyte-bearing tuff at Waha Pele (south-V_s f_s T_s 700 m in diameter and extruded short pahoehoe and aa flows. Collapse of the fragments of country rock, up to 0.5 m in diameter, including trachyte, picritic tholeiitic basalt, and plagioclase-phyric alkali olivine basalt percent plagioclase phenocrysts and locally common xenoliths of dunite, (M. Rubin, written commun., 1984); all the eruptive activity probably

HUALALAI VOLCANO UNITS LESS THAN 1,000 YEARS OLD

is Luamakami, near the west-central edge of the map. Consists of alkali olivine basalt with 2-5 percent oliving phenocrysts. $^{14}\mathrm{C}$ age is 300 \pm 60 years

central edge of map). Early effusive activity built a low spatter cone about central part of the cone occurred and violent phreatic explosions ejected over an area of at least 10 km². Maximum exposed thickness of the resulting light grey to white, weakly-consolidated tuff is about 3 m, but it could be thicker. Extrusion of lava identical in chemical composition to the earlier phase resumed, built a 400-m-diameter cone nested within the earlier cone, and produced a large aa flow that reached the coast about 16 km away. Volume of the erupted basalt is estimated at 400 x 10^6 m³. Spatter cones and flows consist of alkali olivine basalt with 2-4 percent olivine and less than 1 pyroxenite, and gabbro. 14C age of the large youngest flow is 710 ± 150 years occurred within a few months or years.

Spatter deposits, in the south-central part of the map, and lava flows. Early ffusive activity built a low spatter cone about 1 km in diameter and extruded short flows; high fountaining distributed basaltic cinders and scattered small (up to 5 cm) xenoliths of trachyte over an area of several km^2 . Continued lava extrusion constructed a satellitic shield within the cone, and voluminous pahoehoe flows rafted away much of the earlier spatter deposits. Flows changed to aa on steeper slopes and moved as far as 12 km from the vent. Collapse of the summit of the shield formed nested pit craters about 150 and 40 m in diameter; a small eruption of spatter and a flow then partly filled the smaller pit crater. Volume of this map unit is estimated at about $800 \times 10^6 \text{ m}^3$, one of the largest basaltic eruptions in Hawaii. The early spatter, early flows, and voluminous pahoehoe and aa flows consist of alkali olivine basalt with 1-3 percent olivine phenocrysts. The late spatter and flow that partly filled the pit crater consist of alkali olivine basalt with 4-8 percent olivine and 4-8 percent plagioclase phenocrysts. 14C age of the large aa flow that extends to the north is 900 ± 110 years (M. Rubin, written commun., 1984); all the eruptive activity probably occurred within a few years.

2850 Aa flow in the southwest part of the map. Consists of alkali olivine basalt with 1-3 percent plagioclase and less than 1 percent each of olivine and pyroxene phenocrysts.

Aa and pahoehoe flow in the southwest part of the map. Consists of alkali

olivine basalt with 2-4 percent olivine, 1-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts. **Q60544** Aa flow in the southwest part of the map. Consists of alkali olivine basalt with 1-3 percent plagioclase and less than 1 percent each of olivine and roxene phenocrysts. Aa and pahoehoe flow in the southwest part of the map. Consists of alkali

livine basalt with 1-3 percent olivine and 1-3 percent plagioclase phenocrysts. Q57528 Aa flow in the south-central part of the map. Consists of alkali olivine basalt with 2-4 percent olivine and 1-2 percent plagioclase phenocrysts. Q50535 Three spatter cones and associated aa flows in the south-central part of the map. Consist of alkali olivine basalt, transitional to hawaiite, with 5-10 percent plagioclase and 1-2 percent olivine phenocrysts. Small aa flow in the south-central part of the map. Consists of alkali

olivine basalt with 10-15 percent olivine phenocrysts. Q65509 Satellitic shield, consisting of pahoehoe flows, one unmapped dike, and associated spatter deposits, in the south-central part of the map. A deep (>120 m) pit crater formed near the end of the eruption; a small late-stage vent is visible near the bottom of the crater. Lava flows on the lower walls of the pit crater are inaccessible but appear similar to f20,78528 in the large crater (v4069S21) 1.3 km to the west-northwest. Consist of alkali olivine basalt with 1-2 percent olivine and less than 1 percent plagioclase phenocrysts. Q80527 Spatter rampart and a small pahoehoe flow near the center of the map. Consist

f of alkali olivine basalt with 4-8 percent olivine and 1-3 percent plagioclase Pahoehoe flows, with minor spatter deposits and aa, near the center of the map. Cones built at the two vents consist almost entirely of pahoehoe. Similarappearing flows occur on the lower walls of two craters 1.3 and 2.5 km southeast of the vents. Consist of picritic alkali olivine basalt with 15-25 percent olivine phenocrysts.

a flow at Shangri-la (northwest part of map). Consists of alkali olivine basalt with 8-12 percent olivine phenocrysts in a locally feldspathic groundmass. R37545 Aa flow on the east side of Potato Hill (northwest part of map). Consists of fa alkali olivine basalt with 6-10 percent plagioclase, 2-4 percent olivine, and ss than 1 percent pyroxene phenocrysts and scattered xenoliths of gabbro. Aa and pahoehoe flow in the east-central part of the map. Consists of alkali olivine basalt with 3-5 percent olivine phenocrysts.

UNITS 1,000-3,000 YEARS OLD

CASSI Spatter deposits and pahoehoe and aa flows in the south-central part of the map. Initial high fountaining distributed basaltic cinders and abundant $rac{V_4}{f_4}$ small (up to 5 cm) xenoliths of trachyte over a large area (perhaps in excess of 50 km², indicating that the eruption was sub-Plinian). Subsequent Strombolian- and Hawaiian-type activity built a spatter rampart and cone along a line about 650 m long and extruded voluminous pahoehoe and aa flows to the northeast and southeast. Collapse of the vent area near the end of the eruption created a large pit crater; picritic basalt flows from an earlier eruption (f_2 078S28) crop out on the lower walls of this crater. Volume of the erupted products is estimated to exceed 400 x $10^6~\rm m^3$. Cinders, spatter, and flows consist of alkali olivine basalt with 1-2 percent olivine phenocrysts. written commun., 1984).

Spatter deposits near the center of the map and a large aa and pahoehoe flow. Initial eruptive activity built a line of small spatter cones about 1 km long. The eruption became concentrated toward the center of this line, where a large spatter cone was constructed and a voluminous flow was extruded, mainly to Consist of alkali olivine basalt with 2-4 percent olivine and less than 1 percent plagioclase phenocrysts in a locally feldspathic groundmass. Flow

R13543 Spatter deposits and aa and pahoehoe flows in the northwest part of the map. eft-stepping en echelon eruptive vents occur over a distance of 8 km and cut obliquely across the general strike of the diffuse north-trending rifone, changing from N10°W at the northern end (in the Puu Anahulu quadrangle) to N50°F at the southwestern end (Kileo and the next vent to the northeast) Lava first erupted at the lower elevation (1129 m; 3700 feet) and gradually broke out higher (maximum elevation 1830 m--6000 feet) on the volcano's north flank as the eruption progressed. Prolonged eruption built spatter comes at Hainoa and Kalamalu (north edge of map) and at Kileo; relatively low spatter ramparts were built at the other vents. Volume of the eruption is estimated to be $400 \times 10^6 \text{ m}^3$. Consist of alkali olivine basalt with 2-5 percent olivine, 1-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts in a locally feldspathic groundmass. $^{14}\mathrm{C}$ age of the northern flow is 2,030 \pm 80 years (M. Rubin, written commun., 1978); probably all of the lava was extruded over a period of a few months.

Pahoehoe flow in the east-central part of the map. Consists of alkali olivine

basalt with 5-10 percent olivine phenocrysts in a feldspathic groundmass.

basalt with 3-6 percent plagioclase, 1-3 percent olivine, and less than 1

Q71R85 Aa flow in the east-central part of the map. Consists of alkali olivine

percent pyroxene phenocrysts.

plagioclase phenocrysts.

of gabbro, pyroxenite, and dunite.

Aa and pahoehoe flow in the east-central part of the map. Consists of alkali

Spatter cone and an aa and pahoehoe flow in the west-central part of the map. Consist of alkali olivine basalt with 15-20 percent olivine, 1-2 percent

Spatter cone of Puu Neneakolu (southwest part of map) and an aa and pahoehoe

 $Q33\underline{542}$ Spatter cone of Pihapono (southwest part of map) and a pahoehoe flow. Consist

QY8561 Spatter cone and a small pahoehoe flow, confined within the cone, near the

Q32518 Spatter cone of Puu Ikaaka (near south-central edge of map) and an aa and

vent. Consist of alkali olivine basalt, transitional to ankaramite, with

Q98525 Small spatter cone near the center of the map. Consists of alkali olivine

<u>Ra7R78</u> Pahoehoe flow in the northeast part of the map. Consists of alkali olivine

Q775🔌 Small spatter cone near the center of the map. Consists of alkali olivine

<u>ደቴል የ</u>88 Aa flow in the northeast part of the map. Consists of alkali olivine basalt

Small spatter cone in the south-central part of the map. Consists of alkali

olivine basalt with 2-4 percent plagioclase and less than 1 percent olivine

with 1-2 percent olivine and less than 1 percent plagioclase phenocrysts.

Q34502 Spatter cone in the southeast part of the map. Consists of alkali olivine

 V_{a} | basalt with 3-6 percent plagioclase and 1-3 percent olivine phenocrysts.

basalt with 10-15 percent olivine phenocrysts.

basalt with 3-6 percent olivine phenocrysts.

 V_a f_a flow. Consist of alkali olivine basalt with 5-10 percent olivine phenocrysts.

phenocrysts; scattered xenoliths of gabbro are present.

west-central edge of the map. Consist of picritic alkali olivine basalt with 15-20 percent olivine and less than 1 percent each of pyroxene and plagioclase

of alkali olivine basalt with 6-12 percent olivine and less than 1 percent

pahoehoe flow; flow is thickly mantled by cinders and spatter rafted from the

15-20 percent olivine, 5-10 percent pyroxene, and less than 1 percent plagioclase

phenocrysts. Xenoliths of dunite and minor pyroxenite and gabbro are abundant.

Spatter cone of Puu Nahaha (north-central part of map) and a pahoehoe and aa

flow. Consist of alkali olivine basalt with 3-6 percent olivine phenocrysts.

pyroxene, and less than 1 percent plagioclase phenocrysts and common xenoliths

olivine basalt with 2-4 percent olivine and 1-3 percent plagioclase phenocrysts.

Aa flow from Nawahine (v4R00S55), in the northwest part of the map. Consists of alkali olivine basalt with 6-10 percent plagioclase, 1-2 percent pyroxene, and 1-2 percent olivine phenocrysts.

 4 C age of the long flow that extends to the north is 1,180 \pm 200 years (M. Rubin,

the north. Volume of the eruptive products is estimated to be about $400 \times 10^6 \text{ m}^3$. overlies f4R13S43, a $2,030 \pm 80$ -year-old flow, and is overlain by cinders from

Pahoehoe and aa flow from Nawahine (v4R00S55), in the northwest part of the map. Consists of alkali olivine basalt with 1-2 percent olivine phenocrysts. Q98555 Pahoehoe and aa flow from Nawahine (v4R00S55), in the northwest part of themap. Consists of alkali olivine basalt with 4-8 percent olivine, 1-2 percent

plagioclase, and less than 1 percent pyroxene phenocrysts. ROOS55 Spatter and cinder deposits at Nawahine (northwest part of the map). Consist of alkali olivine basalt of three different lithologies, represented by flows f_4 R01S58, f_4 R05S52, and f_4 Q98S55. One small pit crater within this vent deposit exposes an older unmapped biotite-bearing hawaiite flow. Eruptions at Nawahine occurred between 2,390 \pm 60 and 2,030 \pm 80 years B.P. (14c ages from M. Rubin, written commun., 1978-1982).

Q30539 Spatter cone of Puu o Kalaukani (near south edge of map), and a pahoehoe and aa flow. Unit is thickly mantled by trachyte-bearing tuff and basaltic cinders from Waha Pele, 900 m to the east. Consist of alkali olivine basalt with 3-6 percent olivine phenocrysts. 14°C age is 2,290 ± 70 years (M. Rubin, written

 $\begin{picture}(200,0) \put(0,0){\line(1,0){15}} \put(0,$ Spatter cone and an aa flow in the northwest part of the map. Consist of Spatter cone and an aa frow in the northwest part of the lag. sollies alkali olivine basalt with 1-2 percent olivine and 1-2 percent plagioclase phenocrysts. 14C age is 2,390 ± 60 years (M. Rubin, written commun., 1982). 7563 Cinder and spatter cone and an aa flow in the northwest part of the map. Consist of alkali olivine basalt with 2-4 percent plagioclase and 1-2 percent olivine phenocrysts. Cage is 2,670 ± 80 years (M. Rubin, written commun.,

Q43528 Spatter cones of Puu o Mawae (south-central part of map), and an aa and pahoeĥoe flow. Flow is thickly mantled by cinders from Puu o Mawae, Waha Pele, and v5048S12. Consist of alkali olivine basalt with 1-3 percent olivine phenocrysts.

Q85537 Spatter deposits and pahoehoe flows in the west-central part of the map, on the northwest side of Poikahi. Vent deposit is mainly a satellitic shield composed of flows; scattered remnants of spatter are preserved near the rim of a pit crater that formed in the late stages of the eruption. One thin narrow flow extends 4 km to the north; another extends more than 7 km to the south. Consist of alkali olivine basalt with 3-6 percent plagioclase and 3-6 percent olivine phenocrysts in a feldspathic groundmass Pahoehoe flow from Poikahi, in the west-central part of the map. Flow has a prominent lava channel. Consists of alkali olivine basalt with less than 1 ercent olivine phenocrysts.

Q84S30 Aa flow from Poikahi, in the west-central part of the map. Flow is thickly mantled by cinders, mostly from v4069S21 and v4087S24. Consists of alkali olivine basalt with 2-4 percent olivine, 1-3 percent plagioclase, and less han 1 percent pyroxene phenocrysts and scattered xenoliths of dunite and

Spatter cone near the south edge of the map. Consists of alkali olivine basalt with 4-8 percent plagioclase and less than 1 percent olivine phenocrysts. Q95553 Small cinder and spatter cone 200 m east of Kipahee, in the west-central part of the map. Consists of alkali olivine basalt with 2-4 percent olivine, 1-3 percent plagioclase, and less than 1 percent pyroxene phenocrysts.

Q95561 Small spatter rampart and an aa flow in the west-central part of the map. Consists of alkali olivine basalt with 3-6 percent plagioclase and 1-2 percent olivine phenocrysts. Q69513 Spatter cone in the south-central part of the map. Consists of picritic alkali olivine basalt with 15-20 percent olivine and 1-2 percent pyroxene phenocrysts.

Small pahoehoe flow in the northeast part of the map. Consists of alkali olivine basalt with 5-10 percent olivine and 1-3 percent plagioclase phenocrysts. R13R82 Small aa flow in the northeast part of the map. Consists of alkali olivine basalt with 8-15 percent olivine, 3-6 percent plagioclase, and 1-3 percent pyroxene phenocrysts and scattered xenoliths of gabbro. UNITS MORE THAN 10,000 YEARS OLD

Q87574 Spatter cone near the west-central edge of the map. Consists of alkali olivine basalt with 5-10 percent olivine, 3-6 percent pyroxene, and 1-3 percent plagioclase phenocrysts. Q74505 Spatter cone near the center of the map. Consists of alkali olivine basalt with 2-5 percent olivine phenocrysts. <u>Q65S37</u> Small spatter and cinder cone in the southwest part of the map. Consists of alkali olivine basalt with 3-6 percent plagioclase and 1-2 percent olivine

Cinder and spatter cone of Potato Hill (northwest part of map). Consists of alkali olivine basalt with 2-4 percent olivine phenocrysts. Q55547 Spatter cone in the southwest part of the map. Consists of alkali olivine basalt with 2-4 percent olivine phenocrysts. Q38533 Two small spatter cones in the southwest part of the map. Consist of alkali olivine basalt with 4-8 percent olivine phenocrysts.

Q83533 Spatter cone of Poikahi, in the west-central part of the map. Consists of alkali olivine basalt of two lithologic types: the younger has less than 1 percent olivine phenocrysts, and the older contains 2-4 percent olivine, 1-3 percent plagioclase, and less than 1 percent pyroxene phenocrysts and scattered xenoliths of dunite and gabbro. Q81553 Spatter cone of Umiahu (west-central part of map), and a pahoehoe and aa flow.

 V_{+} A small unmapped spatter cone and associated flow, representing the last stages of the eruption, cover the floor of the main crater of Umiahu. Red and brown cinders from Umiahu mantle nearby units. Consist of alkali olivine basalt with 6-12 percent olivine and less than 1 percent plagioclase phenocrysts. Widespread airfall cinders of alkali olivine basalt, representing the products of vigorous Strombolian and sub-Plinian eruptions. Cinder deposits range up to several meters thick and are black, brown, or red. Identified sources are Waha Pele (v5Q28S30), v5Q48S12, v4Q69S21, Nawahine (v4R00S55), v4Q97S63, Puu o Mawae (v4Q43S28), and Umiahu (v4Q81S53). Not mapped where underlying units

UNITS 3,000-5,000 YEARS OLD

Q96557 Spatter cone of Kipahee (west-central part of map), and an aa and pahoehoe flow. Consist of alkali olivine basalt with 3-6 percent plagioclase and 3-6 percent olivine phenocrysts. RO353& Spatter cone and an aa and pahoehoe flow in the northwest part of the map. Consist of alkali olivine basalt with 4-8 percent olivine and 1-2 percent V₃ f₃ Consist of alkali olivine plagioclase phenocrysts. Q92532 Spatter cone and a pahoehoe and aa flow in the west-central part of the map. Consist of alkall ullvine basa.
1 percent olivine phenocrysts. Consist of alkali olivine basalt with 1-3 percent plagioclase and less than . Small spatter cone and a pahoehoe and aa flow in the northwest part of the

map. Consist of alkali olivine basalt with 1-3 percent plagioclase and 1-2 percent olivine phenocrysts. Spatter cone and an aa and pahoehoe flow in the west-central part of the map. Consist of alkali olivine basalt with 1-3 percent plagioclase and less than 1 percent olivine phenocrysts. Spatter deposits in the west-central part of the map. High-standing spatter is surrounded by f3092S32. Adjacent pit crater may have formed initially during the eruption of v3Q96S30, but it also transects f3Q92S32. Consist of alkali olivine basalt with 4-8 percent olivine phenocrysts. **Q455** Spatter cone and aa and pahoehoe flows in the west-central part of the map. **f** Consist of alkali olivine basalt with 1-3 percent olivine and less than 1 percent plagioclase phenocrysts.

Q91552 Two small spatter and cinder cones in the west-central part of the map (500 m v₃ f₃ southeast of Kipahee), and an aa and pahoehoe flow. Consist of alkali olivine basalt with 4-8 percent plagioclase and less than 1 percent olivine phenocrysts.

MAUNA LOA VOLCANO UNITS LESS THAN 1,000 YEARS OLD

Pahoehoe and aa flows, erupted in A.D. 1859 (Stearns and Macdonald, 1946)(east edge of map). Consist of tholeiitic basalt with 1-3 percent olivine phenocrysts. Q 38R50 Pahoehoe flow in the southeast part of the map. Consists of tholeiitic basalt η with 5-10 percent olivine phenocrysts in a feldspathic groundmass. $^{14\text{C}}$ age is 1,150 ± 200 years (M. Rubin, written commun., 1985); flow overlies a Hualalai flow (f_5 Q48S12) dated at 900 \pm 110 years, so both flows probably were erupted about 1,000 years ago.

UNITS 1,000-3,000 YEARS OLD Q26R76 Pahoehoe flow near the southeast edge of the map. Consists of tholeiltic basalt with 1 percent olivine phenocrysts in a locally feldspathic groundmass. Flow overlies Hualalai flow $f_4Q69S21$, which is dated at 1,180 \pm 200 years. R38R50 Aa flow in the northeast corner of the map. Consists of tholeiltic basalt with 1-3 percent olivine phenocrysts and rare xenoliths of troctolite. UNITS 3,000-5,000 YEARS OLD

058850 Large pahoehoe flow, locally with very minor aa, in the east and northeast parts of the map. Flow is dense, vesicle-poor, and characterized by a rind of surficial glass 1-6 cm thick. Consists of tholeiitic basalt generally with 2-4 percent olivine phenocrysts in a locally feldspathic groundmass; rarely, the flow contains lenses with as much as 10-15 percent olivine 225R50 Pahoehoe flow near the southeast corner of the map. Consists of generally

picritic tholeiitic basalt with 10-25 percent olivine phenocrysts in a locally feldspathic groundmass. R23R50 Pahoehoe and aa flow in the northeast part of the map. Consists of picritic tholeiitic basalt with 15-25 percent olivine and 5-10 percent plagioclase phenocrysts. Pahoehoe flow, locally with minor aa, along the east edge of the map. Consists of picritic tholeiitic basalt with 15-25 percent olivine phenocrysts.

Q55RSO Aa and pahoehoe flow at Halelaau (near southeast edge of map). Flow is deeply weathered and stained reddish-brown. Consists of picritic tholeiitic basalt with 15-25 percent olivine and 5-10 percent plagioclase phenocrysts. Pahoehoe flow at Halelaau (near southeast edge of map). Consists of tholeiitic basalt with 3-6 percent olivine phenocrysts in a locally feldspathic groundmass. R45 R64 Pahoehoe flow in three small kipukas near the northeast corner of the map. Consists of tholeiitic basalt with 4-8 percent olivine and 2-6 percent lagioclase phenocrysts.

Q90355 Spatter cone and an aa and pahoehoe flow in the west-central part of the map (500 m south-southeast of Kipahee). Consist of alkali olivine basalt with

Q89541 Cone and a pahoehoe and aa flow in the west-central part of the map. Cone consists almost entirely of flows with very minor spatter. Consist of picritic 3 alkali olivine basalt with 15-20 percent olivine phenocrysts. Spatter cone and a pahoehoe and aa flow in the west-central part of the map. Consist of alkali olivine basalt with 6-10 percent olivine phenocrysts. Spatter deposits and an aa and pahoehoe flow in the west-central part of the $\begin{bmatrix} v_3 & f_3 \end{bmatrix}$ map. Consist of alkali olivine basalt with 2-4 percent olivine phenocrysts.

Q87541 Spatter ramparts and pahoehoe flows in the west-central part of the map. Consist of alkali olivine basalt with 3-6 percent plagioclase phenocrysts. 288540 Two small spatter cones in the west-central part of the map. Consist of V₃ alkali olivine basalt with 2-6 percent olivine phenocrysts. Q73529 Spatter deposits of Kauunuoku (southwest part of map) and five adjacent vents, and pahoehoe and minor aa flows. Consist of alkali olivine basalt with 3-8 percent olivine phenocrysts.

Q85525 Spatter deposits that form four cones (three of which are Mailehahei, Puu Maau, and Kealoha) near the center of the map, and a large aa and pahoehoe flow. Consist of alkali olivine basalt with 10-20 percent olivine, 2-10 percent plagioclase, and 2-10 percent pyroxene phenocrysts and locally n Aa flow in the northeast part of the map. Consists of alkali olivine basalt

with 1-3 percent olivine phenocrysts in a locally feldspathic groundmass. Q62506 Spatter cone and a pahoehoe flow, with eight lava channels radiating from the cone, in the southeast part of the map. Consist of alkali olivine basalt with 1-2 percent olivine and less than 1 percent plagioclase phenocrysts.

Q56518 Satellitic shield of Pohakuloa (south-central part of map), an associated small spatter deposit (v3; shield is included in f3), and pahoehoe and aa 13 flows. Consist of alkali olivine basalt with 10-15 percent olivine phenocrysts Low, left-stepping en echelon spatter ramparts and short pahoehoe and aa flows near the west-central edge of the map; includes a small explosion crater that transects the north flank of Puu Honuaula (y2092S73). Consist of alkali olivine basalt with 2-6 percent olivine, 0-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts. ¹⁴C age is 3,990 ± 70 years

(M. Rubin, written commun., 1982).

Spatter cone of Hinau (southwest part of map) and a pahoehoe flow. Consist of alkali olivine basalt with 4-8 percent olivine and 1-2 percent plagioclase 268539 Pahoehoe and aa flow in the southwest part of the map. Consists of alkali olivine basalt with 1-3 percent olivine phenocrysts.

Pahoehoe flow near the north-central edge of the map. Consists of alkali olivine basalt with 1-2 percent olivine and less than 1 percent plagioclase phenocrysts. Aa flow in the north-central part of the map. Consists of alkali olivine basalt with less than 1 percent each of olivine and plagioclase phenocrysts.

Spatter deposits in the west-central part of the map. Consist of alkali olivine basalt with 2-4 percent plagioclase and 1-2 percent olivine phenocrysts. Q93560 Spatter cone and an aa and pahoehoe flow in the west-central part of the map. Consist of alkali olivine basalt with 10-15 percent olivine phenocrysts. 14C age is 6,360 ± 100 years (M. Rubin, written commun., 1983).

Spatter rampart of Puu Hale (southwest part of map) and an aa and pahoehoe flow. Consist of alkali olivine basalt with 3-6 percent olivine, 1-3 percent plagioclase, and less than 1 percent pyroxene phenocrysts.

Aa and pahoehoe flow in the southwest part of the map. Consists of alkali olivine basalt with 2-4 percent plagioclase and 1-2 percent olivine phenocrysts. Spatter deposits that form two adjoining cones 600 m north of Hainoa Crater, 099569 near the west-central edge of the map; two unmapped dikes of similar composition intrude the underlying v₂Q99S68 in the eastern crater. Consist of alkali olivine basalt with 3-6 percent plagfoclase, 2-4 percent olivine, and less than 1 percent pyroxene phenocrysts and common xenoliths of gabbro.

Q99568 Spatter deposits in the lower crater walls of the eastern cone ($v_2Q99S69$) 600 m north of Hainoa Crater (near west-central edge of map). Consist of $\mathbf{V}_{\mathbf{a}}$ alkali olivine basalt with 4-8 percent plagioclase and 1-2 percent olivine

Spatter and cinder cone of Puu Honuaula (west-central edge of map) and an aa 292573 flow; flow is thickly mantled by rafted cinders and spatter. Consist of Va fa alkali olivine basalt with 5-10 percent olivine and less than 1 percent each of plagioclase and pyroxene phenocrysts. Q92563 Spatter deposits and aa and pahoehoe flows in the west-central part of the

map. Consist of alkali olivine basalt, transitional to ankaramite, with 10-20 percent olivine and 5-10 percent pyroxene phenocrysts and abundant enoliths of dunite, pyroxenite, and gabbro. Q97568 Spatter cone and unmapped dikes 200 m north of Hainoa Crater (near west-central edge of map). Consist of alkali olivine basalt with 3-6 percent olivine, 1-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts. 140 age is $8,770 \pm 200$ years (M. Rubin, written commun., 1983).

REFERENCES Moore, R.B., Clague, D.A., Rubin, M., and Bohrson, W.A., Hualalai Volcano, Hawaii: a preliminary summary of geologic, petrologic, and geophysical data: U.S. Geological Survey Professional Paper 1350 (Hawaiian Volcanism), chapter 20, Stearns, H.T., and Macdonald, G.A., 1946, Geology and ground-water resources of the island of Hawaii: Hawaii Division of Hydrography, Bull. 9, 363 p.

GEOLOGIC MAP SYMBOLS

Subscript (1-5) indicates relative age classification: 5=**<**1,000 years old; 4=1,000-3,000 years old; 3=3,000-5,000 years old; 2=5,000-10,000 years old; A six-character symbol consisting of a letter plus two digits followed by a second letter and two more digits is a unique geographic identifier for each vent deposit and its related flows. The pair of letter-digit-digit combinations represents a pair of coordinates on an island-wide grid based on latitude and longitude (E.W. Wolfe and C.A. Neal, written commun., 1985). The letters represent 6-minute intervals in the grid. In the Hualalai quadrangle, Q or R in the first position correspond, respectively, to latitude 19°36' and 19°42' or 19.6° and 19.7°. Similarly, R or S in the fourth position correspond, respectively, to longitude 155°42' and 155°48' or 155.7° and 155.8°. The two numbers that follow each letter correspond to hundredths and thousandths of degrees. Thus, the identifier Q48S12 refers to a grid position at latitude 19.648° and longitude 155.812°. The identifier for flows hat cannot be traced to vents within the Hualalai quadrangle is chosen arbitrarily to represent the grid position within the quadrangle of the part of the flow closest to the axis of Hualalai's major south-southeast-trending rift zone. Each volcanic map unit is the product of a brief geologic event. In the absence of about the absolute age of a map unit. The units are included in chronostratigraphic groups on the bases of field stratigraphic relationships, the few 14C ages, amount of soil development, and degree of degradation of surface glass and primary flow

features. A bracket on the correlation chart (except for the large bracket with diagonal lines distinguishing the Mauna Loa flows) indicates the possible age range of any unit or sequence of units. Stratigraphic relationships are indicated by the vertical placement on the correlation chart. Contact, approximately located

X Location and age of 14 C-dated charcoal sample (M. Rubin, written commun., 1978-1985) Q/y Relatively older and younger units, at location where relationship is demonstrable ✓✓ Pattern on Mauna Loa flows